

AMENDMENT TO THE CLAIMS:

The following listing of the claims replaces all previous listings and versions:

1. (Currently Amended) A probability density estimation device for an anomalous data detection system adapted to detect anomalous data, said probability density estimation device configured for ~~For use in~~ a degree of outlier calculation device for sequentially calculating a degree of outlier of each data with a data sequence of real vector values as input, asaid probability density estimation device for, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture distribution of normal distributions, said probability density estimation device comprising:

probability calculation means for calculating, based on a value of input data and values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities, a probability of generation of the input data in question from each normal distribution; and

parameter output rewriting means for updating and rewriting the stored parameter values while forgetting past data, according to newly read data based on a probability obtained by the probability calculation means, values of a mean parameter and a variance parameter of each normal distribution and a weighting parameter of each normal distribution.

2. (Currently Amended) The probability density estimation device as set forth in claim 1, further comprising:

parameter storage means for storing values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities and a weighting parameter of each normal distribution, wherein said parameter rewriting means updates and rewrites data of said parameter storage means.

3. (Currently Amended) A degree of outlier calculation device for sequentially calculating a degree of outlier of each data with a data sequence of real vector values as input, said degree of outlier calculation device adapted to detect anomalous data, and comprising:

a probability density estimation device for, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture of normal distributions, said probability density estimation device including:

(a) parameter storage means for storing values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities and a weighting parameter of each normal distribution;¹⁵

(b) probability calculation means for calculating, based on a value of input data and values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities, a probability of generation of the input data in question from each normal distribution;¹⁵ and

(c) parameter rewriting means for updating and rewriting the stored parameter values while forgetting past data, according to newly read data based on a probability obtained by the probability calculation means, values of a mean parameter

and a variance parameter of each normal distribution and a weighting parameter of each normal distribution; and

degree of outlier calculation means for calculating and outputting a degree of outlier of said data by using a parameter of the normal mixture updated by said probability density estimation device and based on a probability distribution estimated from values of the parameters before and after the updating and the input data.

4. (Currently Amended) A probability density estimation device for use in a degree of outlier calculation device adapted for anomalous data detection, the degree of outlier calculation device for to, while sequentially reading a data sequence, estimating estimate a probability distribution of generation of the data in question by using a finite mixture distribution number of normal kernel distributions, the probability density estimation device comprising:

parameter storage means for storing a value of a parameter indicative of a position of each kernel; and

parameter output rewriting means for reading a value of a parameter from the parameter storage means and updating the stored parameter values while forgetting past data, according to newly read data, to rewrite the contents of the parameter storage means.

5. (Currently Amended) A degree of outlier calculation device for sequentially calculating a degree of outlier of each data with a data sequence of real

vector values as input, said degree of outlier calculation device adapted for anomalous data detection, and comprising:

a probability density estimation device for, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture distribution of number of normal kernel distributions, the probability density estimation device including:

(a) parameter storage means for storing a value of a parameter indicative of a position of each kernel; and

(b) parameter rewriting means for reading a value of a parameter from the storage means and updating the stored parameter values while forgetting past data, according to newly read data to rewrite the contents of the parameter storage means; and

degree of outlier calculation means for calculating and outputting a degree of outlier of said data by using said parameter updated by said probability density estimation device and based on a probability distribution estimated from values of the parameters before and after the updating and the input data.

6. (Currently Amended) A histogram calculation device for For use in a degree of outlier calculation device for sequentially calculating a degree of outlier of each data with discrete value data as input, said degree of outlier calculation device useful for anomalous data detection, a histogram calculation device for calculating a parameter of a histogram with respect to said discrete value data sequentially input, said histogram calculation device comprising:

storage means for storing a parameter value of said histogram; and

parameter updating means for reading said parameter value from the storage means and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means, thereby outputting some of parameter values of said storage means.

7. (Currently Amended) A degree of outlier calculation device for sequentially calculating a degree of outlier of each data with discrete value data as input, said degree of outlier calculation device useful for anomalous data detection, and comprising:

a histogram calculation device for calculating a parameter of a histogram with respect to said discrete value data sequentially input, said histogram calculation device including:

storage means for storing a parameter value of said histogram; and parameter updating means for reading said parameter value from the storage means and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means, thereby outputting some of parameter values of said storage means; and

score calculation means for calculating, based on the output of the histogram calculation device and said input data, a score of the input data in question with respect to said histogram, thereby outputting the output of the score calculation means as a degree of outlier of said input data.

8. (Currently Amended) A degree of outlier calculation device for calculating a degree of outlier with respect to sequentially input data which is described both in a discrete value and a continuous value, said degree of outlier calculation device useful for anomalous data detection, and comprising:

a histogram calculation device for estimating a histogram with respect to a discrete value data part;

a number of probability density estimation devices, the number equal provided as many as to the number of cells of said histogram, the probability density estimation devices for estimating a probability density with respect to a continuous value data part;

cell determination means for determining to which cell of said histogram said discrete value data part belongs to send the continuous data part to the corresponding one of said probability density estimation devices; and

score calculation means for calculating a score of said input data based on a probability distribution estimated from output values of said histogram calculation device and said probability density estimation device and said input data, thereby outputting the output of the score calculation means as a degree of outlier of said input data;

said histogram calculation device including:

storage means for storing a parameter value of said histogram; and parameter updating means for reading said parameter value from the storage means and updating past parameter values while forgetting past data based on

input data to rewrite the value of said storage means, thereby outputting some of parameter values of said storage means; and

said probability density estimation device including:

parameter storage means for storing values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities and a weighting parameter of each normal distribution;

probability calculation means for calculating, based on a value of input data, and values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities, a probability of generation of the input data in question from each normal distribution; and

parameter rewriting means for updating and rewriting the stored parameter values while forgetting past data, according to newly read data based on a probability obtained by the probability calculation means, values of a mean parameter and a variance parameter of each normal distribution and a weighting parameter of each normal distribution.

9. (Currently Amended) A degree of outlier calculation device for calculating a degree of outlier with respect to sequentially input data which is described both in a discrete value and a continuous value, said degree of outlier calculation device useful for anomalous data detection, and comprising:

a histogram calculation device for estimating a histogram with respect to said discrete value data part;

a number of probability density estimation devices, the number equal to
~~provided as many as~~ the number of cells of said histogram for estimating a probability density with respect to a continuous value data part;;

cell determination means for determining to which cell of the histogram said discrete value data part belongs to send the continuous data part to the corresponding one of said probability density estimation devices; and

score calculation means for calculating a score of said input data based on a probability distribution estimated from output values of said histogram calculation device and said probability density estimation device and said input data, thereby outputting the output of the score calculation means as a degree of outlier of said input data;,

said histogram calculation device including:

storage means for storing a parameter value of said histogram; and

parameter updating means for reading said parameter value from the storage means and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means, thereby outputting some of parameter values of said storage means; and

said probability density estimation device including:

parameter storage means for storing a value of a parameter indicative of a position of each kernel; and

parameter rewriting means for reading a value of a parameter from the storage means and updating the stored parameter values while forgetting past data, according to newly read data to rewrite the contents of the parameter storage means.

10. (Currently Amended) A probability density estimation method for
~~For use in~~ a degree of outlier calculation device for sequentially calculating a degree of outlier of each data with a data sequence of real vector values as input, said degree of outlier calculation device useful for anomalous data detection, said a probability density estimation method of, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture of normal distributions, the method comprising the steps of:

based on values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities read from parameter storage means for storing a value of input data, values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities, and a weighting parameter of each normal distribution, calculating a probability of generation of the input data in question from each normal distribution; and

updating the stored parameter values while forgetting past data, according to newly read data based on a probability obtained by the probability calculation means, values of a mean parameter and a variance parameter of each normal distribution and a weighting parameter of each normal distribution to rewrite data of said parameter storage means.

11. (Currently Amended) A degree of outlier calculation method of
sequentially calculating a degree of outlier of each data useful for anomalous data
detection, with a data sequence of real vector values as input, including wherein a

probability density estimation for, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture of normal distributions, the probability density estimation comprising comprises the steps of:

based on values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities read from parameter storage means for storing a value of input data, values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities, and a weighting parameter of each normal distribution, calculating a probability of generation of the input data in question from each normal distribution; and

updating the stored parameter values while forgetting past data, according to newly read data based on a probability obtained by the probability calculation means, values of a mean parameter and a variance parameter of each normal distribution and a weighting parameter of each normal distribution to rewrite data of said parameter storage means;— said method of sequentially calculating a degree of outlier of each data and which further comprising comprises the step of:

calculating and outputting a degree of outlier of said data by using a parameter of the finite mixture distribution updated by said probability density estimation and based on a probability distribution estimated from values of the parameters before and after the updating and the input data.

12. (Currently Amended) A probability density estimation method for use in calculation of a degree of outlier useful for anomalous data detection to, while

sequentially reading a data sequence, estimate a probability distribution of generation of the data in question by using a finite mixture distribution of number of normal kernel distributions, said probability density estimation method comprising the steps of:

storing a value of a parameter indicative of a position of each kernel in parameter storage means; and

reading a value of a parameter from the storage means and updating the stored parameter values while forgetting past data, according to newly read data to rewrite the contents of the parameter storage means.

13. **(Currently Amended)** A degree of outlier calculation method of sequentially calculating a degree of outlier of each data, said degree of outlier calculation method useful for anomalous data detection, with a data sequence of real vector values as input, wherein probability density is estimated estimation for, while sequentially reading said data sequence, estimating a probability distribution of generation of the data in question by using a finite mixture distribution of kernel number of normal kernel distributions, the degree of outlier calculation method comprising comprises the steps of:

storing a value of a parameter indicative of a position of each kernel in parameter storage means;

reading a value of a parameter from the storage means and updating the stored parameter values while forgetting past data, according to newly read data to rewrite the contents of the parameter storage means, and which further comprises: the parameter storage means including degree of outlier calculation means for calculating and outputting a degree of outlier of said data by using said parameter updated by said

probability density estimation and based on a probability distribution estimated from values of the parameters before and after the updating and the input data.

14. (Currently Amended) A histogram calculation method for ~~For~~ use in calculation of a degree of outlier for sequentially calculating a degree of outlier of each data with discrete value data as input, said calculation of the degree of outlier useful for anomalous data detection, said a histogram calculation method, said histogram calculation method of calculating a parameter of a histogram with respect to said discrete value data sequentially input, comprising the steps of:

reading said parameter value from storage means for storing a parameter value of said histogram and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means; and
outputting some of parameter values of said storage means.

15. (Currently Amended) A degree of outlier calculation device for sequentially calculating a degree of outlier of each data with discrete value data as input, said degree of outlier calculation device useful for detecting anomalous data, and comprising:

a histogram calculation device for calculating a parameter of a histogram with respect to said discrete value data sequentially input, including:
storage means for storing a parameter value of said histogram; and

parameter updating means for reading said parameter value from the storage means and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means, thereby outputting some of parameter values of said storage means; and

score calculation means for calculating, based on the output of the histogram calculation device and said input data, a score of the input data in question with respect to said histogram, thereby outputting the score calculation result as a degree of outlier of said input data.

16. (Currently Amended) A degree of outlier calculation method of calculating a degree of outlier with respect to sequentially input data which is described both in a discrete value and a continuous value, calculation of the degree of outlier useful for detection of anomalous data, wherein a histogram calculation which estimates a histogram with respect to a discrete value data part, said method comprising comprises the steps of:

reading said parameter value from storage means for storing a parameter value of said histogram and updating past parameter values while forgetting past data based on input data to rewrite the value of said storage means; and

outputting some of parameter values of said storage means, and wherein in probability density estimation devices provided as many as the number of cells of said histogram for estimating a probability density with respect to a continuous value data part, said method comprises the steps of:

based on values of a mean parameter and a variance parameter of each of a finite number of normal distribution densities read from parameter storage means for storing a value of input data, values of a mean parameter and variance parameter of each of a finite number of normal distribution densities and a weighting parameter of each normal distribution, calculating a probability of generation of the input data in question from each normal distribution; and

based on a probability obtained by the probability calculation means, values of a mean parameter and a variance parameter of each normal distribution and a weighting parameter of each normal distribution, updating the stored parameter values while forgetting past data, according to newly read data to rewrite the data of said parameter storage means; and wherein said method further comprises the steps of:

determining to which cell of said histogram said discrete value data part belongs to send the continuous data part to the corresponding one of said probability density estimation devices;

calculating a score of said input data based on a probability distribution estimated from output values of said histogram calculation device and said probability density estimation device and said input data; and

outputting the score calculation result as a degree of outlier of said input data.